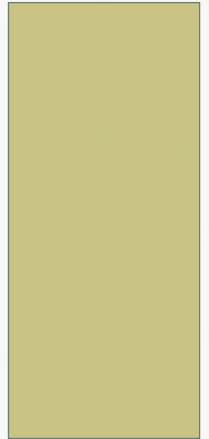


# LED CUBE & DUBSTEP MACHINE

TYSON MORLOCK - AARON AABERG  
JARED GRATZEK - DANE SWARTZ

SD1206  
ADVISOR: DR. SCHROEDER

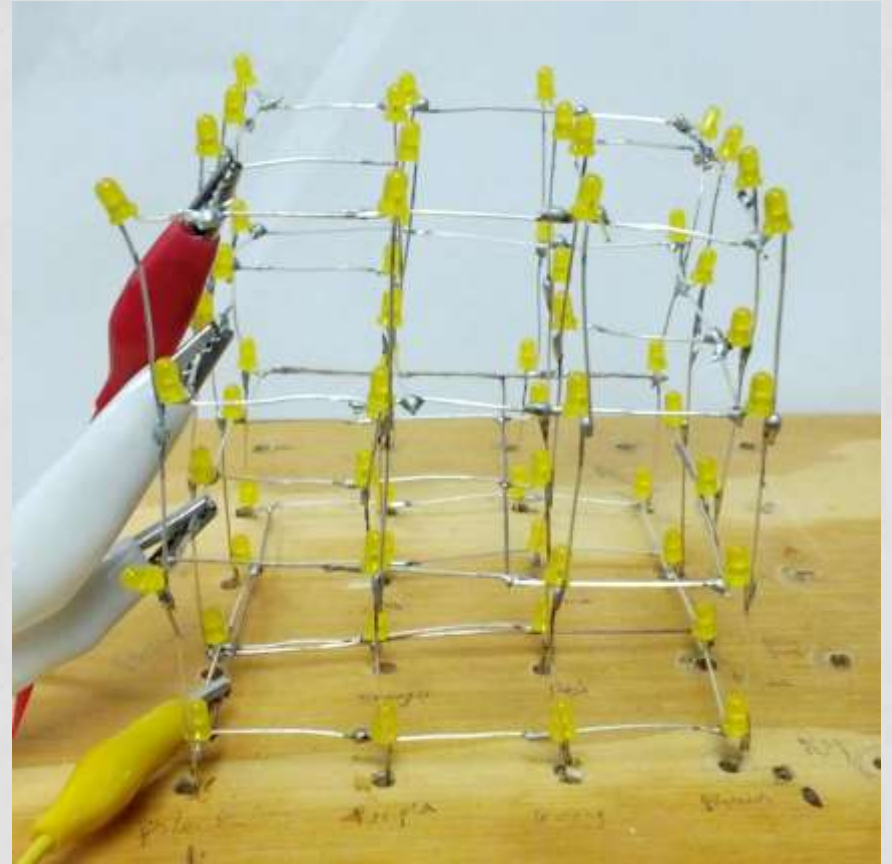


# INTRODUCTION

Back in the 70's there was a novel possession found in almost every best room, this glorious device was the Lava Lamp. This object has had a great impact on pop culture ever since. Fast forward 40 years and Lava Lamps have essentially gone extinct. Now is the time to revive the idea of this eye pleasing lamp and update it with technology from the 21<sup>st</sup> century. We proudly present the LED Cube.

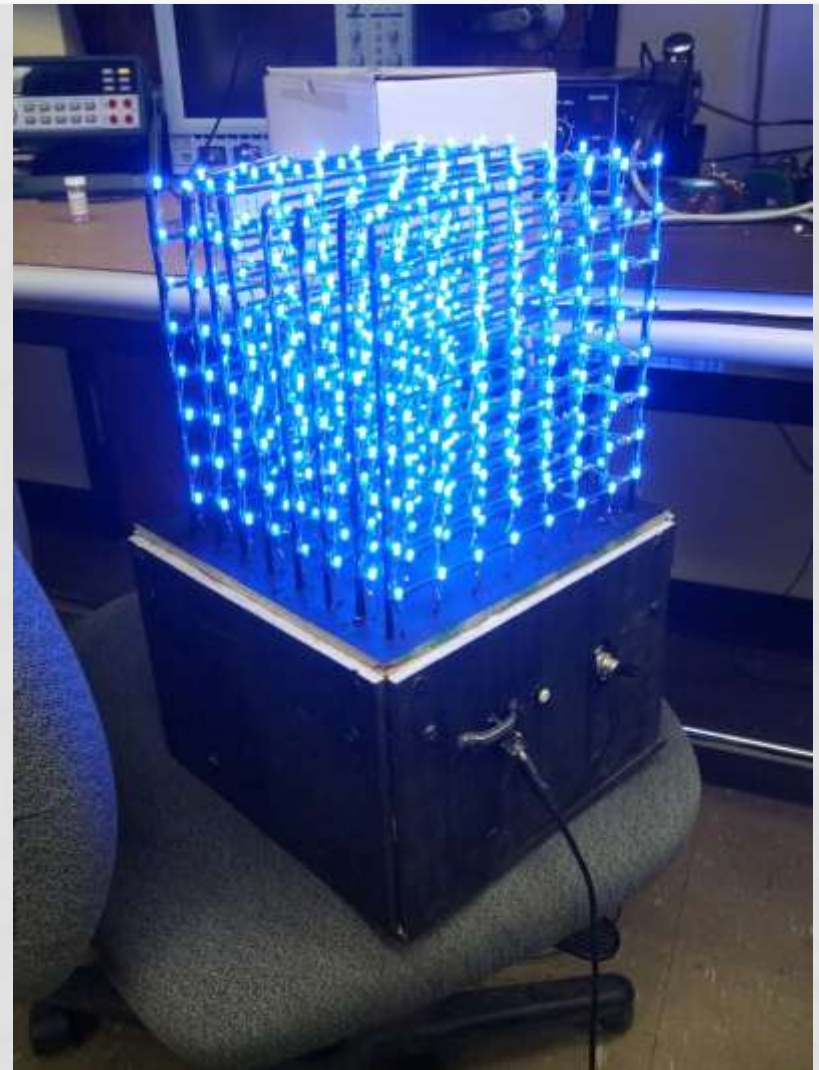
# LED CUBE - PROTOTYPE

We've modernize the lava lamp. This device consists of 512 LEDs formed in an 8x8x8 cube. A music source and be sent into the device and transformed into an amazing lightshow for all ages.



# LED CUBE - FINISHED

We've modernize the lava lamp. This device consists of 512 LEDs formed in an 8x8x8 cube. A music source and be sent into the device and transformed into an amazing lightshow for all ages.

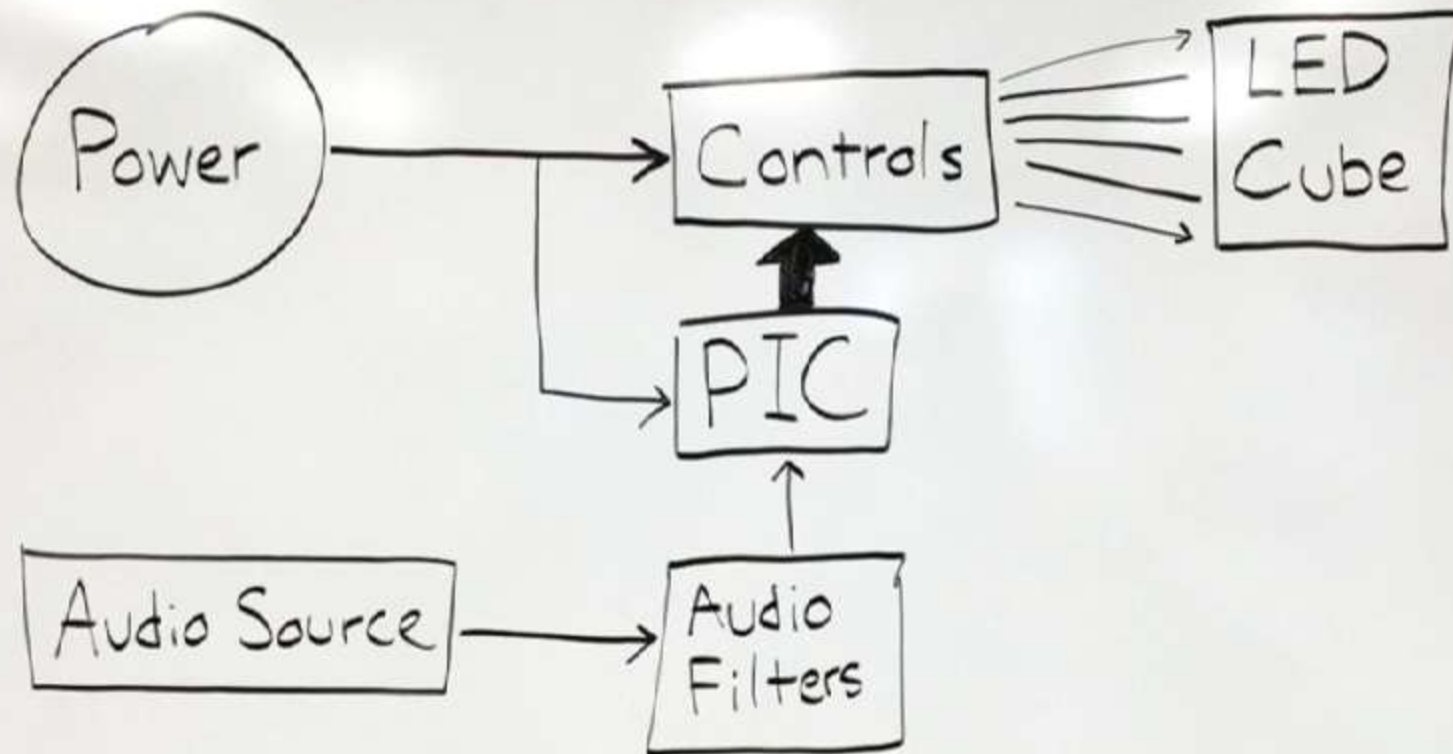


# REQUIREMENTS

## **LED Cube:**

- ✓ This device will consist of 512 LEDs formed in an 8x8x8 cube.
- ✓ The LED cube will be assembled using a copper frame. The LEDs will be directly soldered to copper bars which will be fastened together to forming eight layers. These eight layers will be uniformly painted black and assembled identically. Arranging the separate layers together will lead to the 8x8x8 cube.
- ✓ The Cathode post – short leg – will be soldered to the copper bar which will be grounded. The Anode post – long leg – will be power. This scheme will be as followed: columns=power, rows=grounded.
- ✓ The housing for the LED cube will be contained inside of a clear plexiglas case.
- ✓ All resulting circuitry will be out of sight, contained inside of a housing.
- ✓ LEDs can be turned on separately and controlled individually.
- ✓ The cube will be able to response to audio.
- ✓ The LED cube will receive a signal through a 3.5mm stereo audio jack, allowing for multiple source devices (MP3 player, dubstep machine, CD player, etc.).
- ✓ If the device is turned on and no audio signal is present, the LED cube will go into a preprogrammed effect mode.

# BLOCK DIAGRAM



# TECHNICAL CONTENT

- LED Cube Hardware: **Jared**
- Audio Filter Hardware: **Dane**
- LED Cube Software: **Aaron**
- Dubstep Machine: **Tyson**
- ~~Dubstep Machine: **Jacob**~~

# LED CUBE HARDWARE

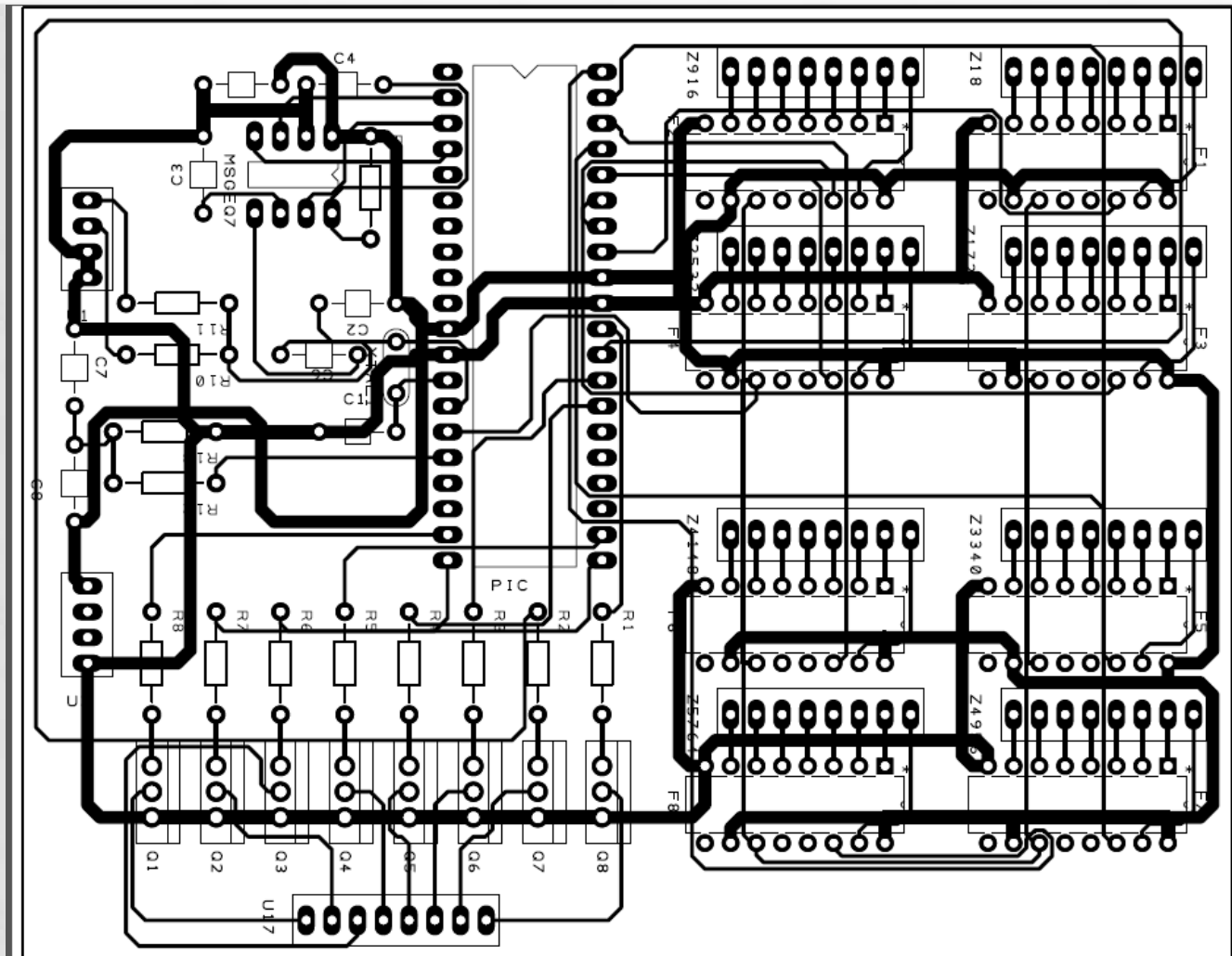
*PRESENTED BY JARED GRATZEK*

- Hardware Design
- Structure
- Cover/Housing
- PCB and PCB soldering
- Parts
- Power Supply
- Switch
- Tool choice
- Making due with what you have



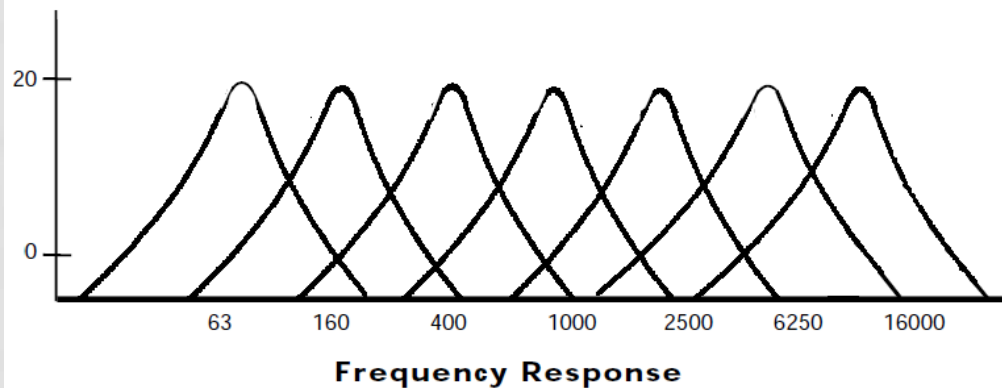
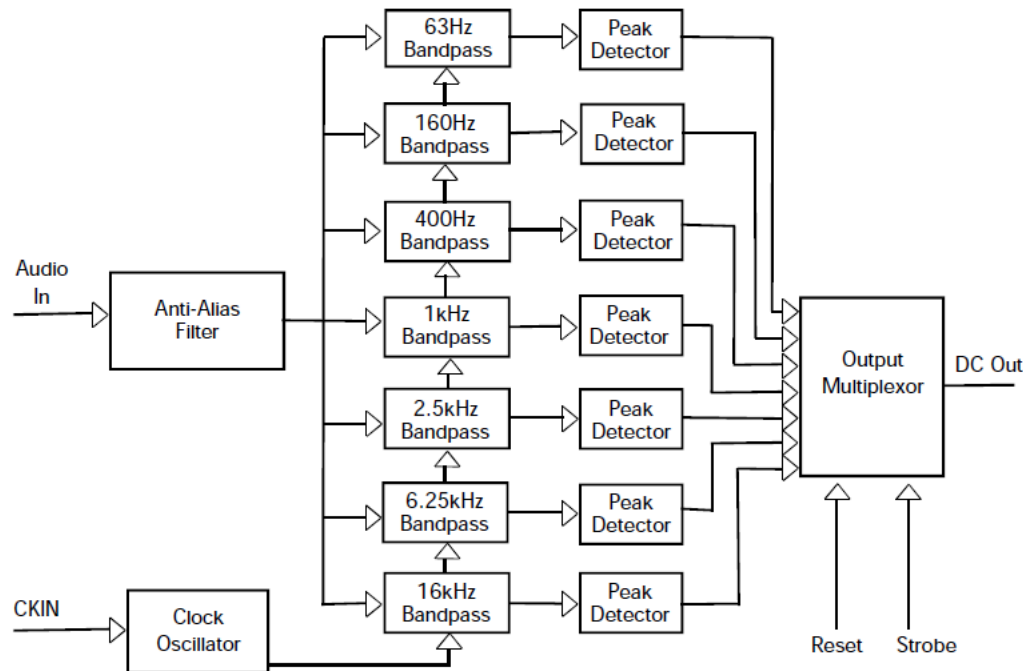
# LED CUBE HARDWARE

*PRESENTED BY JARED GRATZEK*



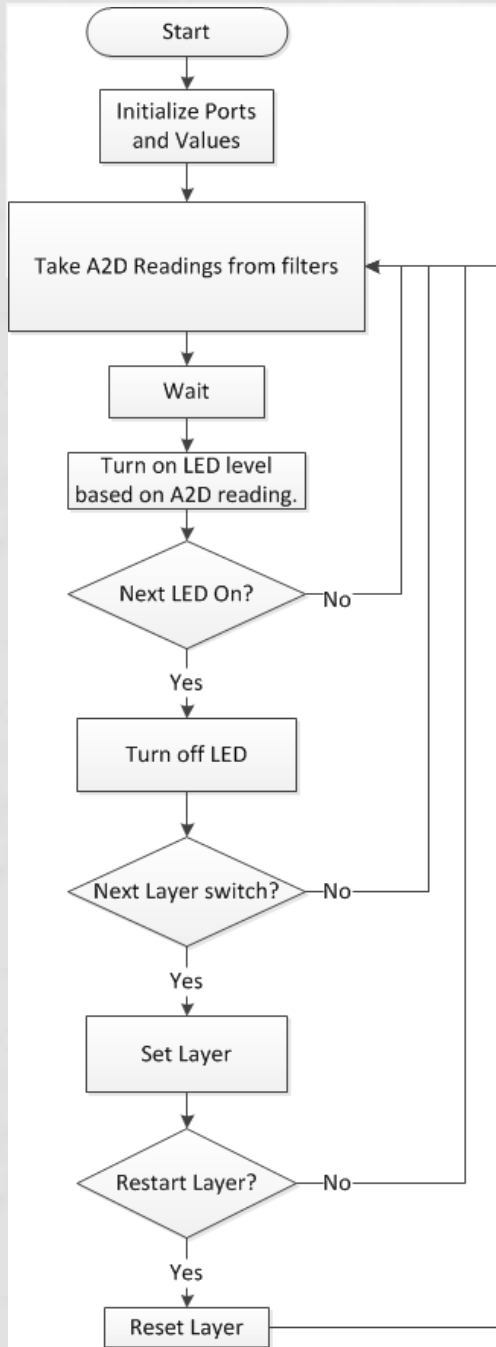
# LED CUBE FILTERS

*PRESENTED BY DANE SWARTZ*



# LED CUBE SOFTWARE

*PRESENTED BY AARON AABERG*

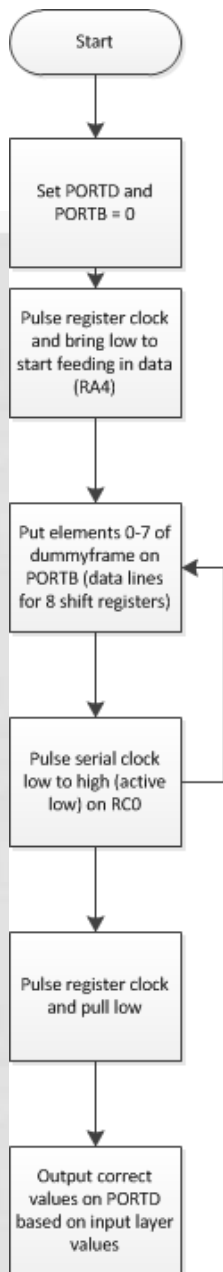


## OLD

The code reads an input audio signal and decide the amplitudes after being passed through filters. The magnitude of the reading will then be processed and turn on the corresponding LED light.

# LED CUBE SOFTWARE

*PRESENTED BY AARON AABERG*



Repeat 8 times for 8 slots on 8 shift registers

`changecolumns(int Layer1, int Layer2, int Layer3, int Layer4, int Layer5, int Layer6, int Layer7, int Layer8, int wait_time)`

Edit global variable `dummyframe[64]` in subroutines and call `changecolumns`

# LED CUBE SOFTWARE

*PRESENTED BY AARON AABERG*

Used to animate any picture you can make on a LED cube:

- Different size cubes
- Sparkles
- Letters
- “Rain”
- Stacking layers
- Sphere

Animating a object you have to switch between layers and edit the dummy frame as you go.

# LED CUBE SOFTWARE

## *PRESENTED BY AARON AABERG*

```
void cube2(int time)
{
    for (int p_c2 = 0; p_c2<64; p_c2++)
    {
        dummyframe[p_c2] = 0;
    }
    dummyframe[18] = 1;
    dummyframe[19] = 1;
    dummyframe[20] = 1;
    dummyframe[21] = 1;
    dummyframe[20] = 1;
    dummyframe[21] = 1;
    dummyframe[26] = 1;
    dummyframe[29] = 1;
    dummyframe[34] = 1;
    dummyframe[37] = 1;
    dummyframe[42] = 1;
    dummyframe[43] = 1;
    dummyframe[44] = 1;
    dummyframe[45] = 1;
    changecolumns(0,0,1,1,1,1,0,0,time);
}
```

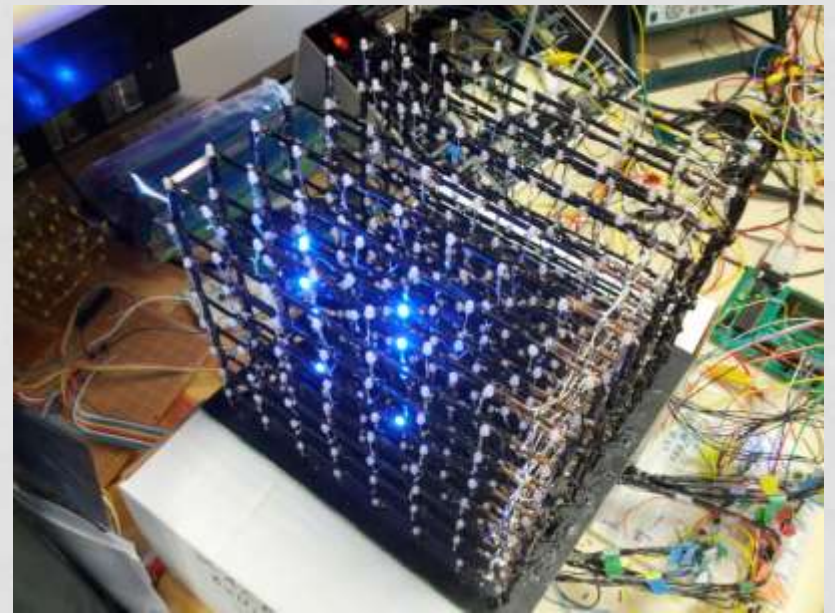
```
for (int p = 0; p<64; p++)
{
    dummyframe[p] = 1;
    changecolumns(0,0,0,0,0,0,1,1);
    dummyframe[p] = 0;
}

for (int p = 0; p<64; p++)
{
    dummyframe[p] = 1;
    changecolumns(0,0,0,0,0,0,1,0,1);
    dummyframe[p] = 0;
}

for (int p = 0; p<64; p++)
{
    dummyframe[p] = 1;
    changecolumns(0,0,0,0,0,1,0,0,1);
    dummyframe[p] = 0;
}

for (int p = 0; p<64; p++)
{
    dummyframe[p] = 1;
    changecolumns(0,0,0,0,1,0,0,0,1);
    dummyframe[p] = 0;
}
```

# LED CUBE SOFTWARE



# TESTING AND EVALUATION

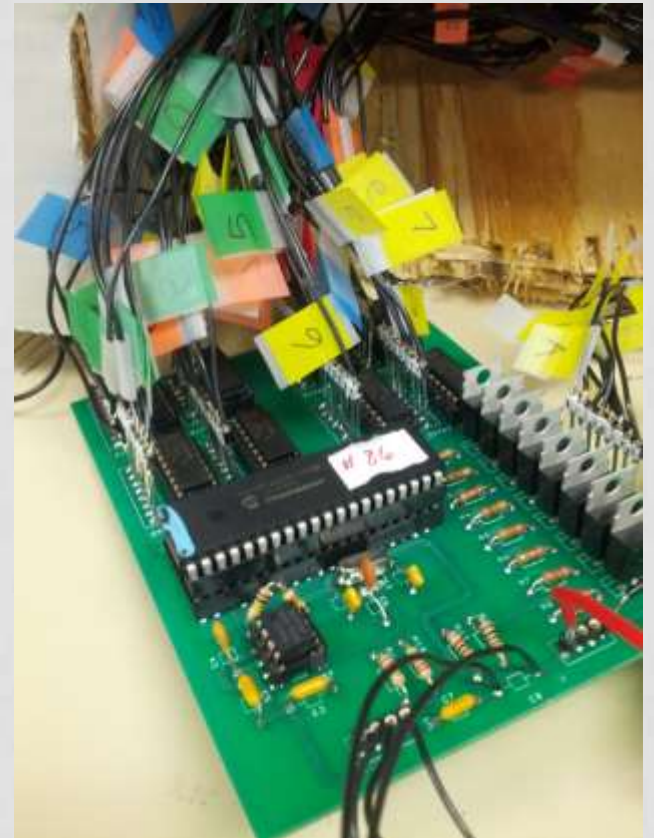
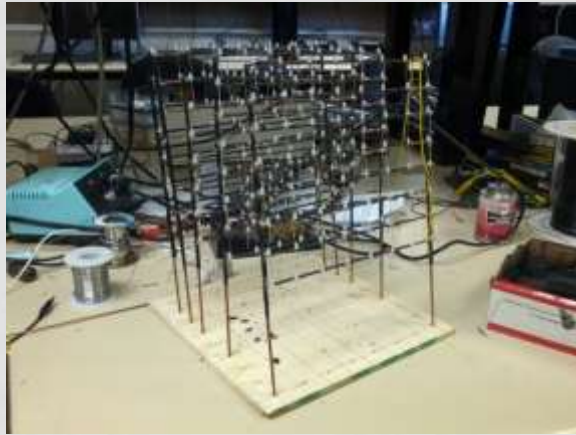
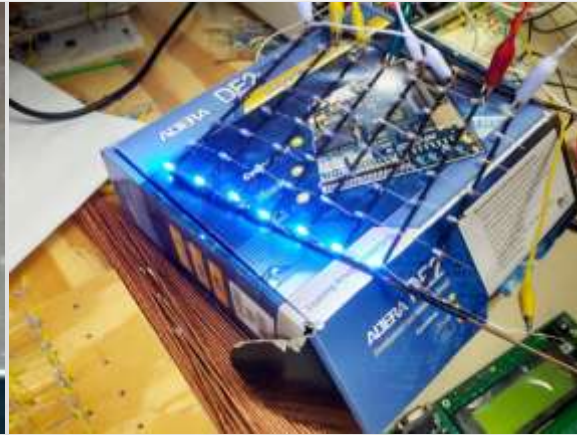
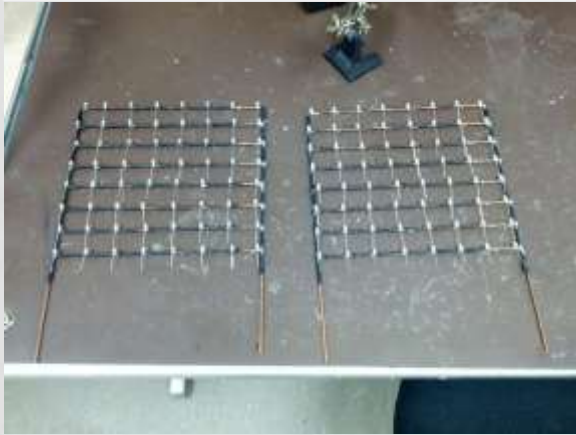
- Put heartbeat to see if portions of the code is working.
- Create Matlab scripts to create an audio spectrum sweep
- Turn on all LED's on the cube to see if connections are good
- See if visually it “bounced” to the music
- Isn't affected by volume of the output speaker
- Tested connections continuously with a multimeter



# TESTING AND EVALUATION

- Bottom-up programming –starting small and building up piece by piece
- Breakout files to easily add or subtract pieces of code
- Realizing the LED's were dimmer than expected
- Trying new things and knowing when to quit trying to get it to work and move to something that can work.
- Prototyping the cube
- Equipment

# PICTURES



# PROBLEMS ENCOUNTERED

- We found our shift registers would store values from previously ran code which caused glitches and errors in our mode switching.
- Out of scope errors
- 1) Debugging with optimizations on can make variables appear out of scope (obviously)
- 2) Volatile does not necessarily fix the out of scope problem, at least for the attempted local variables
- 3) "Isolate each function in a section" option which passes -ffunctions-sections option to the compiler may alleviate the out of scope problem.

# PROBLEMS ENCOUNTERED

- Feedback from audio circuit
- Cheap speakers
- How to clock a shift register
- Bad chips
- incorrectly reading datasheets
- Dangerous equipment
- Is it getting power?
- Ordering PCB's
- Rods/Structure
- Always trying to change the project
- Backing up code
- Connections
- Software
- Hardware
- Design
- Presentations
- Meetings
- Jobs

# LESSON LEARNED

- Aim low so that you can hit your mark
- Document stuff better
- Get everyone on the same page
- Plan modularly
- Don't get engaged during a Senior Design project
- Don't try to juggle a full time co-op with senior design
- Seemingly simple things can make for complex problems

# BUDGET

Component	Estimated	Price	Total
100 LEDS	\$21	Free	Free
500 LEDS	\$250	\$40	\$40
Mounting Supplies	\$20	Free	Free
Audio Processor	\$150	\$20	\$20
3.5mm Audio Jack	\$5	Free	Free
Block of Wood	Free	Free	Free
Electrical Parts	\$50	\$20	\$20
Housing	\$25	\$40	\$40
MP3 Player	\$15	\$15	Free
Keyboard (Piano)	\$200	Free	Free
Speaker	\$40	Free	Free
Outsource PCB	\$60	\$50	\$50
Super Glue	\$4	\$4	\$4
Rubber Cement	\$5	Free	Free
Spray Paint	\$4	\$4	\$4
PIC Processor Components	\$99	Free	Free
Audio Splitter	\$10	Free	Free

**Budget**  
**Old Total: \$500**  
**2<sup>nd</sup> Semester Total: \$401**  
**Final Total: \$178**

# FUTURE WORK – DESIGN IMPROVEMENTS

- Structure – especially rods
- Easier to mount LED's –rope/tape, etc.
- RGB LED's
- More modes
- Bigger Sized cube
- Smaller sized base
- Efficient wiring
- Stricter labeling of firmware revisions
- More novel light-up method

# FUTURE WORK – RELATED FUTURE PROJECTS

- Modular cubes that stack together
- A bigger LED cube
- LED cube that reacts to eye patterns while you sleep
- LED cube that reacts to touch
- 3D video research with LED lighting scheme
- Wireless Cube



# SUMMARY

We didn't have software done to our own standards before we could start the final assembly.

We chose rods to support the structure of the cube and it partially worked.

We have created a 8x8x8 LED Cube which reacts based upon the audio signal processed (based off of music).

It also has different mode settings that are controlled by a pushbutton switch.

# SUMMARY

We have created a 8x8x8 LED Cube which reacts based upon the audio signal processed (based off of music).

It also has different mode settings that are controlled by a pushbutton switch.

We had several modes that stopped working so we left them out to make our finish product.

We choose to work with what we had working already to make a finished product.

Knowing we had a deadline, we made a finished product.

We fell short of our personal goals for this project (programming we are ~month late), but still met our requirements for this project.

Ground work for the first ever Dubstep Machine is formed. Two wave forms have been added together to drive speaker.

More information on project available at the follow link:

<http://saturn.ece.ndsu.nodak.edu/ecewiki/index.php/SD1206>

Short link: <http://bit.ly/SD1206>

# REQUIREMENTS

## **Dubstep Machine:**

- Design the 1<sup>st</sup> ever hardware-only based dubstep modulator
- Make it user friendly (so anybody can play live dubstep music)
- Integrate different effects and frequency modulations that can be played live

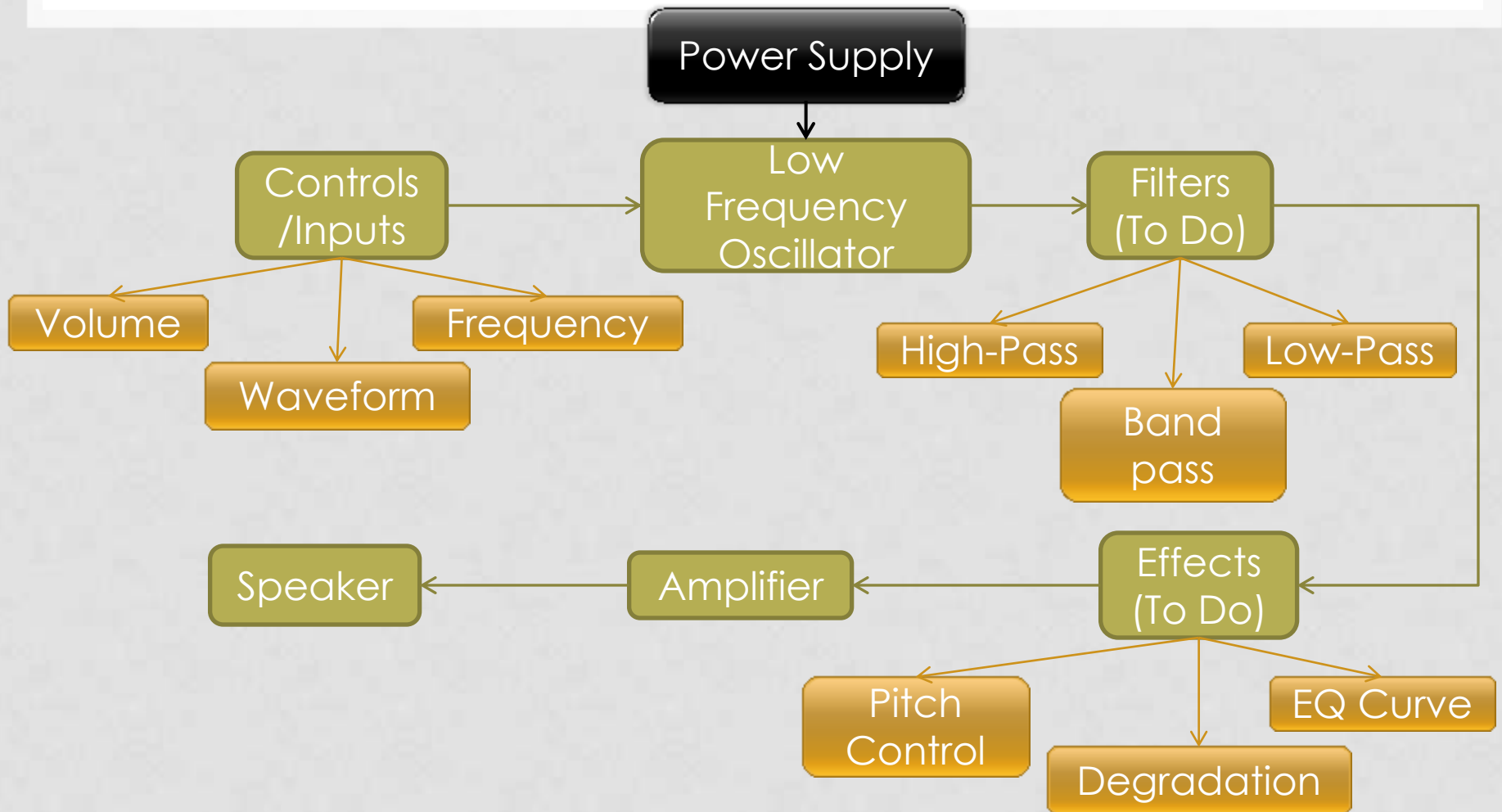
# DUBSTEP MACHINE

*PRESENTED BY TYSON MORLOCK*

- Dubstep is created typically through software
  - Using MIDI Controllers and Complex Music Software
    - Software combines Low-Frequency Oscillators (LFO's) with sound waves (Notes or Music Tones) to create a wobble effect
    - The LFO acts as an envelope for the incoming sound or note
    - After this, different effects and filters are added to tweak the sound as desired
    - Multiple LFO's can be overlapping to create multiple envelopes for an even more unique sound
  - Most, if not all, of these can be created using hardware
    - The goal is to replace MIDI controllers with a dubstep controller to play dubstep live with analog sound

# DUBSTEP MACHINE

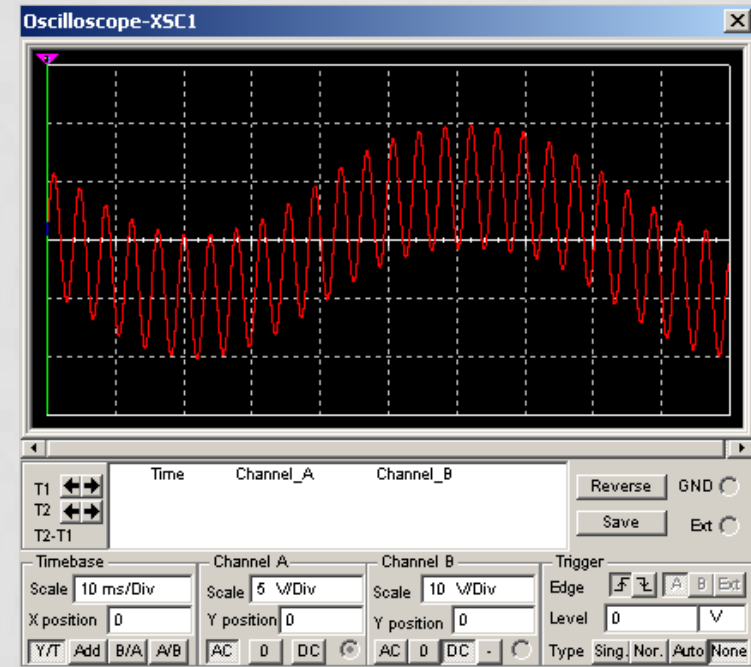
*PRESENTED BY TYSON MORLOCK*



# DUBSTEP MACHINE

*PRESENTED BY JACOB GOODELL*

- Signal Processing
  - Sound or note signal has to be added to the LFO using a summing circuit
    - This will cause the sound to oscillate at the rate of the LFO
      - Rate of LFO: 0.111 to 25 Hz
      - Sound signal: 20 to 20,000 Hz
  - The addition of these two waves is what causes the “Dubstep” or wobble sound



# DUBSTEP MACHINE

- What is “Dubstep?”
  - Rising genre of electronic music
    - Becoming very popular, it is even found in new mainstream music with artists such as:
      - Korn, Britney Spears, Snoop Dogg, Rihanna & More
  - Originated in Europe and now becoming more popular in the US
  - Known of having a low, bass modulation (“wobble”) pattern for this type of music

Foster the People – Pumped Up Kicks  
(Butch Clancy Remix)

# QUESTIONS?

